ICT & ELAS: Training and Women's Empowerment in the Exploration of Augmented Reality and Virtual Reality, Building Bridges Between Gender and Technology

Cecília dos Santos Oliveira[1], Carina Santos Silveira[2], France Ferreira de Souza Arnaut[3]
[1]Federal University of Bahia – Institute of Science, Technology and Innovation; [2]Federal Institute of Education, Science and Technology of Bahia; Salvador, Bahia, Brazil

The "ICT & ELAS" project aims to train girls in high school and elementary school II from public schools in the metropolitan region of Salvador in augmented reality (AR) and virtual reality (VR) technologies. The project aims to transform the approach to social challenges by integrating these tools, promoting female empowerment and gender equality. Through AR and VR, the project aims to raise awareness, educate and engage students, encourage awareness and collective action on gender and ethnicity issues, and expand the dialogue with socio-educational initiatives in the capital of Bahia. As research that aims to generate knowledge, it is methodologically categorized as applied. This article concludes by presenting the results achieved.
Keywords: Augmented Reality (AR), Virtual Reality (VR). Female Empowerment. Gender Equality. Socio-Educational Initiatives.

Augmented Reality (AR) and Virtual Reality (VR) combine knowledge abstraction with cognitive recognition of the results of practical technological applications. These technologies can provide 3D visualizations and simulations without needing real-world experimentation, demonstrating their effective educational potential. Through sensory immersion, they enhance user experience and facilitate meaningful student learning. Additionally, they are perceived as innovative and highly engaging tools.

With the increasing availability of technological innovations and the dissemination of knowledge, learning platforms, collaborative spaces, open educational resources, and learning objects have emerged, increasing the demand for training in digital technologies. The market inclusion of future professionals will depend on their mastery of technology and its application as a problem-solving tool. AR and VR in teaching practices can help address specific content or facilitate laboratory experiences that cannot be conducted within the traditional classroom setting of public institutions.Moreover, these technologies can be easily replicated and reused in various contexts, enhancing the user experience.

The historically exclusionary nature of education in Brazil is gradually giving way to opportunities for economically and culturally vulnerable communities to access quality education. This represents a modest but significant advancement in promoting inclusion and social equality.

The project aligns with the three pillars of the university—teaching, research, and outreach—which are often inseparable. The outcomes obtained contribute to education and research, providing expertise in science, technology, and innovation. This culminates in the execution of workshops, documentation of participant experiences, and scientific publication. Additionally, the project aspires to collaborate with schools to train new multipliers who can further disseminate its impact.

Contextualization of the Theme

Gender inequality in technology and exact sciences remains a persistent issue in many societies worldwide. Despite significant progress in increasing female participation across various sectors, the technology landscape reflects deep disparities. Historically, women have been underrepresented in technology-related

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Address for correspondence: Cecília dos Santos Oliveira. Rua do Telégrafo, SN. Zipcode: 42802-721. Camaçari, Bahia, Brazil. E-mail: ceciliao@ufba.br.

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professions, often due to social and cultural barriers that discourage their participation.

These barriers start early, with a lack of encouragement in school environments, gender stereotypes that associate technology and science with predominantly male professions, and a scarcity of successful female role models in these fields. Studies show that when girls are exposed to the world of technology and encouraged to participate, they perform just as well as, or even better than, boys. However, many abandon pursuing technological careers due to a lack of representation and institutional support.

According to UNESCO, as of 2020, only 30% of scientists worldwide are women [1]. In Brazil, female researchers make up 40.3% of the total. Women in vulnerable situations often face multipl6. e challenges, including limited access to education, gender-based violence, financial constraints, labor market discrimination, healthcare access difficulties, and a lack of political representation. Additionally, according to the Atlas of Social Vulnerability in Brazilian Municipalities [2], the country's Northeast region presents high Social Vulnerability Index (IVS) figures, directly impacting the education available to the population.

Projects like ICT & ELAS aim to mitigate gender barriers in the technological field by encouraging young girls to reflect on the discussed social context and apply AR (Augmented Reality) and VR (Virtual Reality) technologies. By training girls in emerging technologies, the project provides an opportunity to engage and empower them in traditionally male-dominated areas. The primary goal is not only to offer technical training but also to foster confidence and self-efficacy, allowing participants to see themselves as capable of contributing to and thriving in high-tech fields. Additionally, the project seeks to challenge the cultural barriers students face, empowering them to become agents of change within their communities.

AR, VR, and UX in Education: Broadening Perspectives

Augmented Reality (AR) and Virtual Reality (VR) in educational settings can be applied in various ways. One of the main benefits is the ability to provide real-time three-dimensional simulations, enabling the exploration of complex concepts such as anatomical structures, chemical reactions, or even abstract mathematical ideas. These technologies allow students to manipulate virtual objects and interact with them in real-time, enriching comprehension and facilitating learning subjects that traditionally require expensive or inaccessible physical equipment.

Additionally, the interactivity provided by these technologies transforms the learning environment into a more dynamic and engaging experience. According to Tori and Hounsell (2018) [3], immersion and presence are key elements in defining the success of a virtual environment. Immersion refers to the system's ability to engage the user's senses, while presence is the psychological sensation of "being inside" that environment. This reinforces AR and VR's ability to capture students' attention, fostering active learning that resembles real-life experiences. Tori and Hounsell (2018) [3] point out that "*VR systems already allow for response times of less than 10 ms*," enabling high-quality interactions applicable in various contexts.

The impact of these technologies on education is directly linked to promoting experiences that engage multiple senses, providing a deeper understanding of content, which contributes to meaningful learning. Cybis and colleagues (2010) [4] state that "*user experience (UX) emerges from the interaction between humans and technology*," incorporating emotional aspects. According to the authors, UX arises from this interaction, offering a comprehensive perspective that integrates aesthetic, functional, and interactive properties, shaping how people respond physically and cognitively.

As Hekkert (apud Mont'Alvão and Damazio) [5] defines the experience with a product as

"*a set of effects triggered by the interaction between a person and a product, including the degree to which all our senses are gratified (aesthetic experience), the meanings attributed to the products (experience of meaning), and the feelings and emotions that are evoked (emotional experience)*."

The design of AR and VR environments is anchored in understanding the desired user experiences. Thus, AR and VR are powerful tools for promoting UX, especially in increasing technological integration within the educational landscape.

AR and VR Environments: Hedonistic and Functionalist Interactions

AR and VR environments should provide both hedonistic and functionalist interactions, ensuring that students feel a sense of belonging in the experiences associated with the presented content.This ultimately leads to an improvement in education quality and a reduction in the vulnerability of affected populations. Jordan (2000) [6] understands that human beings constantly pursue pleasure, often obtained through direct interaction with products. Emotional, hedonic, and practical benefits drive this pursuit. Practical benefits result from completing specific tasks using the product.

Emotional benefits stem from how a product affects a person's mood. Hedonic benefits relate to the sensory and aesthetic pleasures associated with a product. From this perspective, the design of AR and VR environments is guided by emotion. From Baxter's (2000) [7] perspective, subject-object interaction can occur through attractiveness, which fosters engagement. An attractive product captures attention and pleases the user, and this attraction can take four distinct forms:

- **Familiarity** – Attraction to what is already known.
- **Functional or Semantic Attraction** – Based on usefulness and meaning.
- **Symbolic Attraction** – Related to cultural and social significance.
- **Inherent Visual Attraction** – Based on aesthetic appeal.

Thus, the visual appearance of AR and VR environments acts as a gateway to interaction, facilitating an exchange of information with users within a dialogical interaction context (which includes experiences, social and cultural backgrounds, attention, and interest). Through this dialogue, meaningful interaction emerges. It can be maintained in two ways:

- **Holistically** – A broad perspective of the environment.
- **Detailed Observation** – Systematic analysis based on defined criteria guided by aesthetic perception.

The study by Ricca (2019) [8] encourages critical reflection on the unrestricted use of digital interactive artifacts in mediating experiences. The author questions the assumption that "*simply using such artifacts automatically results in a satisfactory experience.*" Ricca emphasizes that the digital media production market in Brazil is growing. However, responsive interfaces, such as lights, projections, buttons, sounds, and screens, may be an essential tool for knowledge mediation and visitor engagement.

VR headsets, such as the Quest 2 (Figure 1), represent a revolution in education. They offer an immersive experience that goes beyond traditional teaching methods. This technology enables the creation of interactive three-dimensional environments, deeply engaging students and transforming abstract concepts into visual and tangible experiences.

Materials and Methods

According to Fonseca (2002) [9], research enables an approximation and an understanding of the reality under investigation as a continuous and unfinished process. The author also states that scientific research

Figure 1. Quest 2 VR headset.

results from a detailed inquiry or examination to solve a problem using scientific procedures.

A scientific investigation examines a person or a qualified group (the subject of the investigation) while addressing an aspect of reality (the object of the investigation) to:

- Experimentally confirm hypotheses (experimental research),
- Describe phenomena (descriptive research), or
- Explore new aspects (exploratory research).

Due to its nature, the proposed project is classified as applied research, which, according to Silva (2005) [10], aims to generate practical knowledge for solving specific problems. This research is designed to develop a model to be integrated into science education practices through technological inclusion for girls.

In this context, the research was developed through the following stages:

- Mapping and selecting participants
- Planning qualification instruments
- Designing and producing content
- Executing planned activities

  Evaluating and validating activities.

Development: Planned and Executed Activities with Schoolgirls

Initially, schools in the surrounding area were mapped based on the accessibility for girls and the availability of physical facilities. Two schools were identified, and contact was established with teachers. Teachers were asked to form groups of girls (between 5 and 10 participants) for the activities. These girls were expected to act as multipliers within and outside the selected schools.The selection also considered their availability, interest in participating, and social vulnerability criteria.

During phases 2 (planning of qualification instruments) and 3 (content planning and production), the project team and school teachers brainstormed the best approach, considering the students' profiles. It was decided that workshops would be offered to introduce fundamental concepts of AR and VR, culminating in a discussion circle about contemporary issues, including the application and ethics of these technologies. The following key challenges were established for the planning phase:

- Provide training on AR and VR principles and applications, offering theoretical and practical knowledge to spark interest and build confidence in these technologies.
- Encourage the creation of support networks among participants, fostering knowledge sharing and experience exchange
- Inspire creativity and innovation in the use and development of these technologies.

To execute the planned activities, the university laboratory and dedicated spaces within the participating schools were used for school visits. The workshops (Figure 2) were conducted by a student scholarship holder from the project and mediated by the supervising professor and the fundamental education teacher.

In the first phase, the girls were introduced to the content about these technologies. In the second phase, they were encouraged to use VR headsets, including the Quest 2 model, Warrior model, and cardboard VR viewers (the latter two using smartphones). Finally, the discussion circle served as a culminating moment, allowing for an evaluation and validation of the activity.

The workshops conducted with Colégio Estadual Polivalente de Camaçari students

Figure 2. Participants of one of the workshops: Teachers and students.

marked a milestone in training young girls. The participants had the opportunity to interact with technologies that previously seemed distant from their daily lives—all reported never having had contact with the presented content and equipment. The use of VR headsets sparked interest and curiosity, leading to enriching discussions about the potential of these technologies. From their very first experience with the VR headsets, the girls exhibited enthusiasm and curiosity. While experimenting with the immersion provided by Quest 2, many reported feeling "transported" to new worlds—an experience that inspired reflections on how this technology could be applied to their lives and careers. Some participants commented that they had never imagined interacting with a virtual environment, which led to debates on VR's endless possibilities in fields such as education, healthcare, and entertainment.

The interaction with technology sparked questions among them about the future of professions. "*How far can this technology go*?" was a recurring question. The discussions revolved around the possibilities of applying AR and VR in various fields, such as teaching history—through the recreation of historical moments—or in medicine with virtual surgery training. The girls began envisioning scenarios where they could be creators of these experiences rather than just consumers. In this sense, the workshop introduced the technology and opened up a new horizon for these young women, now considering careers in science and technology.

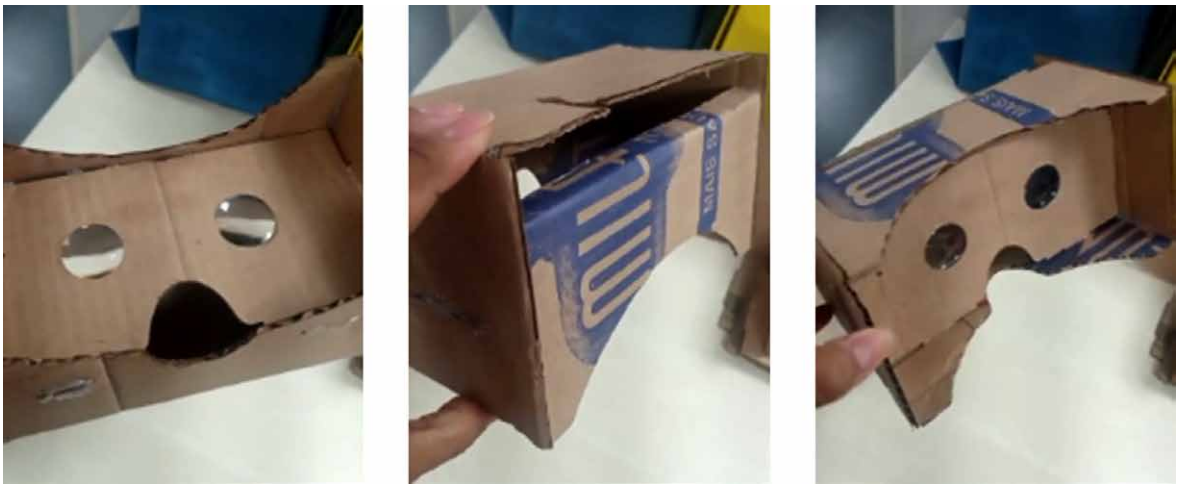
The use of the Quest 2 headset, one of the most advanced VR devices, was a highlight of the workshop. The girls experienced high-quality graphics, immersion, and interaction provided by the device. Some described the experience as "incredible" and "unforgettable," emphasizing the sensation of being in another place, interacting with virtual elements as if they were real. This experience was essential for them to understand the impact of VR on their daily lives and future career choices.

Other key aspect of the workshop was using VR headsets made from accessible materials, such as cardboard (Figure 3). This exercise showed the girls that technology does not have to be inaccessible or expensive. They could build their own VR headsets using low-cost materials, utilizing smartphones as screens. The cardboard headset was donated to the school.

Conclusion

AR and VR technologies have emerged as innovative and transformative tools in the

Figure 3. Prototype of the developed and tested VR headset.



educational field, providing new forms of student engagement and promoting a more interactive and meaningful learning experience. These immersive environments facilitate the understanding of complex concepts and broaden access to quality education, positively impacting the teaching process and including historically underrepresented groups, notably women in science and technology.

Initiatives such as the ICT & ELAS project highlight the potential of AR and VR technologies in promoting equal opportunities and strengthening the empowerment of girls in contexts of social vulnerability. The 25 participants in the workshops showed high engagement levels as they interacted with these emerging technologies. The immersion provided by VR devices such as the Quest 2 sparked a genuine interest in technology, fostering discussions about the future of professions and the possibilities these tools offer. The hands-on experience and the construction of VR headsets using low-cost materials demonstrated the potential for democratizing access to the technological world, inspiring these young women to explore new educational and professional opportunities.

The adoption of AR and VR in the educational context not only enhances the learning experience but also contributes to building a more inclusive education. Demystifying access to digital tools promotes the inclusion of young people in innovative and technological job markets. By empowering individuals and expanding their digital competencies, these tools play a crucial role in building a fairer, more innovative society ready to face the challenges of the 21st century

It is recommended that the project continue expanding activities to include lectures and debates with recognized women in the field so they can share their experiences, create an open space for discussions about challenges and opportunities, and inspire the students. The target audience should be expanded to include elementary and high school girls. Practical workshops should be held on creating accessible VR headsets, designing VR environments, and developing 3D models in AR. Additionally, mentorship and personalized guidance should be offered to assist participants in developing their projects and enhancing their technical skills while encouraging network formation.

The use of AR and VR in a problematizing context can transform how we approach and solve social challenges. These technologies offer new ways to raise awareness, educate, and engage students, promoting awareness, empathy, and collective action to address issues related to gender and ethnic belonging.

It is also worth emphasizing the social strengthening of this action through the involvement of university extension projects as a

space for dialogue with the community, promoting knowledge transfer, co-creation of knowledge, exchange of experiences, and formation of collaborative networks. The project provided a space for direct interaction between the university and society, demonstrating its commitment to the training and development of women in science and technology. It also facilitated the exchange and encouragement of knowledge through co-creation alongside teachers from the schools.

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